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Vanadium Isotopic Composition and
Concentrations of Ferromagnesian Elements
in Returned Lunar Samples

Final Report
(Grant NGR 15-005-134)

prepared by

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Research Summary

The primary purpose of this investigation was to search for the effects of an energetic charged particle irradiation of solar system material which has been postulated as having taken place early in its history (see attached paper for specific references). A similar irradiation has taken place much more recently in the history of lunar samples and meteorites and this process has been studied by means of a variety of monitors including highly sensitive noble gas nuclides, radionuclides and tracks. Such monitors cannot be used to study the postulated early irradiation since it could have taken place under conditions such that these monitors were not retained or were subsequently lost. Accordingly it is necessary that a non-gaseous element be used to search for the effects of this irradiation and one of the most sensitive of these is the vanadium isotopic composition. We have made a comparative study of the $^{50}\text{V}/^{51}\text{V}$ ratios in 15 meteoritic, 5 terrestrial and 11 lunar samples, of which research on 6 meteorites, 2 terrestrial and 7 lunar samples was supported by this grant.

As a result of this study we found that the $^{50}\text{V}/^{51}\text{V}$ ratios in lunar tend to be slightly higher than those in meteorites, the difference in the weighted group means lying just at the margin of significance, i.e. the $\geq 95\%$ confidence level. While this difference may reflect an irradiation effect, it seems to us more likely that it reflects a long term difference in mass-discrimination of the mass-spectrometer. We feel it safest to use this difference to establish upper limits for the difference in integrated charged particle fluxes experienced by lunar and meteoritic matter. These limits, $10^{18} - 10^{20}$ protons/cm² (the exact limit depending on the particle spectrum chosen), are considerably lower

than those postulated. If an early irradiation occurred, either all matter now constituting the earth, moon and meteorites was thoroughly mixed or the integrated particle fluxes and proportions of irradiated and shielded material were virtually identical in those parts of the solar system from which these different objects were derived.

Our secondary aim was to investigate some aspects of the selenochemistry of vanadium by determining its concentrations (by isotope dilution) and those of the ferromagnesian elements, chromium, iron, magnesium and titanium (by atomic absorption spectrometry) in lunar samples. We found that the concentrations of vanadium generally parallel those of chromium and/or iron in fines, basalts and a breccia, the ratios of each of these two elements to vanadium increasing as their concentrations increase. This, in turn, indicates either that all three elements are sited in the same minerals or that the host minerals for each vary sympathetically. The data for these three elements in CI chondrites indicate that the Cr/V ratio is similar to those of lunar samples while the Fe/V ratio is somewhat higher than in lunar samples. If the moon is derived from material similar in composition to chondrites, its formation and evolutionary processes were not accompanied by substantial fractionation of chromium and vanadium.

Publications

The following publications are based wholly or partly upon support by grant NGR 15-005-134.

1. Vanadium Isotopic Composition and the Concentrations of It and Ferromagnesian Elements in Lunar Material.

P. Rey, H. Balsiger and M. E. Lipschutz, Proceedings of the Third Lunar Science Conference, Vol. 2 (D. Heymann, editor) 1779-1786 (1972) M.I.T. Press.

2. Vanadium Isotopic Composition and Ferromagnesian Element Contents of Three Apollo 15 Samples.

M. E. Lipschutz, H. Balsiger, P. Rey, I. Z. Pelly and M. D. Mendia
To be submitted to Proceedings of the Fourth Lunar Science Conference, Vol. 2. (1973).

3. Vanadium Isotopic Composition and Contents in the Dark Portions of Gas-Rich Meteorites.

H. Balsiger, I. Z. Pelly, M. D. Mendia and M. E. Lipschutz.
In Preparation.

Five (5) copies of the first publication are enclosed. Copies of the other two papers will be forwarded when they are completed.

Distribution

- 5 - NASA, Office of Scientific and Technical Information
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